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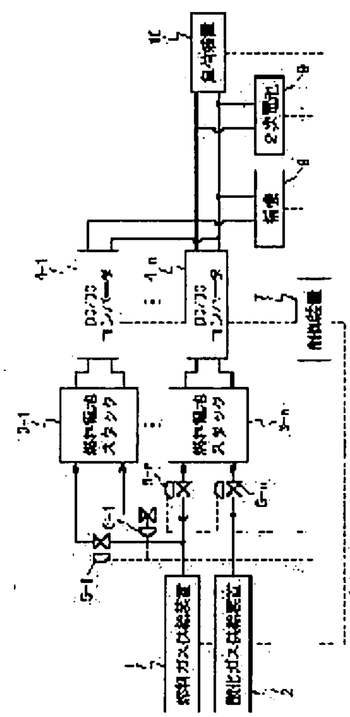
(54) FUEL CELL SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To keep the consuming amount of fuel gas in each fuel cell stack constant independent of the fuel cell stack when the fuel cell stacks are connected in parallel.

SOLUTION: This fuel cell system has a plurality of fuel cell stacks 3-1 to 3-n and a plurality of power converters 4-1 to 4-n. The fuel cell stacks 3 generate power with fuel gas and oxidizing gas supplied. The power converters 4 are connected to the fuel cell stacks 3 and convert the characteristics of the power of the fuel cell. A control device independently controls each of the power converters 4-1 to 4-n. Each set of the fuel cell stack 3 and the power converter 4 is connected in parallel. The control device 7 controls each output current of the fuel cell stacks 3-1 to 3-n with each of the power converters so that the fuel utilization factor of each of the fuel cell stacks 3-1 to 3-n is made equal.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the system which makes equal the output current between fuel cell stacks in the case of carrying out parallel connection of two or more fuel cell stacks especially about a fuel cell system.
[0002]
[Description of the Prior Art] The outline of a fuel cell system is explained using drawing 2 . Drawing 2 is drawing showing the conventional fuel cell structure of a system. A fuel cell system possesses the fuel gas feeder 101, the oxidization gas transfer unit 102, the fuel cell stack 103, DC to DC converter 104, a control unit 107, auxiliary machinery 108, and a rechargeable battery 109. And it connects with load equipment 110 and power is supplied to load equipment 110.
[0003] The fuel gas feeder 101 supplies the hydeogen-rich gas which reforms hydrogen or a methanol, a gasoline, etc. and is obtained to the fuel cell stack 103. The oxidation gas transfer unit 102 supplies oxygen or air to the fuel cell stack 103. The fuel cell stack 103 generates electricity using hydrogen and oxygen. Here, the fuel cell stack 103 may connect not only the case of an independent stack but two or more stacks to the case where it connects with a serial, and juxtaposition. DC to DC converter 104 changes the direct current power generated by the fuel cell stack 103 into the direct current power which has a desired property. A control unit 107 controls the whole fuel cell system. Auxiliary machinery 108 is the fuel pump which supplies the air compressor which supplies air to the oxidation gas transfer unit 102, a methanol, a gasoline, etc. to the fuel gas feeder 101, the cooling water pump which supplies cooling water to the fuel cell stack 103, a flow control valve, etc. Although not illustrated, it is close with the fuel gas feeder, the oxidation gas transfer unit, and the fuel cell stack. If a rechargeable battery 109 is used for supply of the power for starting of the fuel cell stack 103, or load-effect absorption and responds to need quantity of electricity, a capacitor is also possible for it. However, instead of a rechargeable battery 109, external powers (source power supply etc.) can be used for the power for starting, and as long as a load effect is within the limits of the load responsibility of fuel cell power, you may not be. In the case of a vehicle use fuel cell system, load equipment 110 is an inverter for a car drive, a motor, etc. In the case of the fuel cell system of a deferment mold, it is a commercial inverter etc.
[0004] Usually, the fuel cell stack 103 is used together with a rechargeable battery 109 for starting or load-effect absorption. At the time of starting, auxiliary machinery 108 receives an electric power supply from a rechargeable battery 109, and starts the fuel cell stack 103. If a generation of electrical energy of the fuel cell stack 103 is attained, the fuel cell stack 103 will begin an output. And when the load of load equipment 110 is small, the power of auxiliary machinery 108 and load equipment 110 is provided with the output of the fuel cell stack 103, and dump power is charged at a rechargeable battery 109. When a load is large, the power of auxiliary machinery 108 and load equipment 110 is provided with the output of the fuel cell stack 103 and a rechargeable battery 109.
[0005] Here, the fuel cell stack 103 combines two or more fuel cells (cel). In a cel, even when the variation in the property on manufacture is small, in the fuel cell stack 103 for which two or more cels gathered, the variation may become large. As a cause of variation, the reasons of operational status, such as reasons of manufacture and temperature, etc. can be considered.
[0006] For example, drawing 3 showed the situation of variation about the V-I property. Drawing 3 is a graph which shows the output current (I) of the fuel cell stack in hydrogen flow rate regularity, and relation with output voltage (V). As shown in drawing 3 , a difference is looked at by the V-I property like Curves A, B, and C by the fuel cell stack. When such three fuel cell stacks are considered, in the case where they are connected to a serial, the output current I of each fuel cell stack becomes equal (I0). Therefore, the consumption of hydrogen becomes equal also with each fuel cell stack. namely, hydrogen consumption -- being equal (a fuel utilization

rate-depending on a fuel cell stack and being fixed) -- it can carry out. On the other hand, although output voltage V is fixed (V0) when connecting them to juxtaposition, variation arises in the output current I. Therefore, the fuel cell stack with little output current I (curvilinear A:I=I1) wants hydrogen for the fuel cell stack (curvilinear C:I=I2) with not much large hydrogen. That is, hydrogen consumption serves as an ununiformity (a fuel utilization rate is different with a fuel cell stack). The technique which the hydrogen consumption at the time of parallel connection does not depend on a fuel cell stack, but can be considered as regularity (it sets to all fuel cell stacks, and is a fixed current) is searched for.

[0007] Each following technique is indicated as a technique which connects a fuel cell stack to juxtaposition. The technique of a fuel cell generation-of-electrical-energy system is indicated by the patent No. 2745776 official report. When this technique connects each fuel cell stack to juxtaposition, it is controlling the gas supply volume to each stack according to each output current. That is, it controls to make the flow rate of fuel gas small to a fuel cell stack with little output current, and to set a fuel utilization rate constant in all fuel cell stacks by parallel connection (electrical-potential-difference regularity). In this case, if the flow rate of fuel gas is lessened, the V-I property of a fuel cell stack will be changed in response to effect. And by change of a V-I property, it is electrical-potential-difference regularity and the case where the output current becomes small further can be considered. If it becomes so, since the need of lessening the flow rate of fuel gas again will come out, it is thought that control may become unstable. The same possibility can be considered, although the flow rate of fuel gas will be made [many] when the output current is large.

[0008] The technique of the operation preparation approach of a direct-current generation-of-electrical-energy facility is indicated by JP,7-201354,A. This technique makes the group of series connection which becomes equal [the output current] combining those each about two or more fuel cell stacks which have variation in a cell property. And the variation in a cell property is adjusted by carrying out parallel connection of those groups. In this case, the problem of ** that combination of a fuel cell stack cannot be changed during operation in which the case where there is no optimal combination is possible among two or more fuel cell stacks can be considered.

[0009] The technique of a fuel cell power plant is indicated by JP,8-50902,A. After forming a DC/AC inverter in each fuel cell stack and doubling output voltage with a transformer, parallel connection of this technique was carried out, and it is combined. In this case, in the hybrid system (drawing 2) as stated above using a rechargeable battery, it is inapplicable. If it is going to apply by force, it is necessary to newly add an AC/DC converter to the latter part of a DC/AC inverter, and to change into direct current power again.

[0010] The technique of a fuel cell power plant is indicated by JP,8-138689,A. The difference of output voltage at the time of fixing the output current in a fuel cell stack is absorbed to a fuel cell stack by the variable resistance linked to a serial, and this technique is carrying out parallel connection to it. In this case, since the heat loss by resistance occurs, it is possible that system efficiency falls.

[0011] Moreover, when parallel connection of the fuel cell stack was carried out, conventionally, it is a premise to operate all total fuel cell stacks, and making it operate, stop and maintain (repair, exchange, etc.) was not performed according to the individual. This is for arranging all fuel cell stacks in one installation (container) in many cases. The technique in which actuation, a halt, and maintenances (repair, exchange, etc.) are possible is asked for the fuel cell stack according to the individual.

[0012]

[Problem(s) to be Solved by the Invention] Therefore, the purpose of this invention is offering a fuel cell system with it, when connecting a fuel cell stack to juxtaposition. [able for the fuel gas consumption in each fuel cell stack not to depend on a fuel cell stack, but to presuppose that it is fixed]

[0013] Moreover, other purposes of this invention are offering the fuel cell system in which actuation, a halt, and maintenances (repair, exchange, etc.) are possible according to an individual for a fuel cell stack in the fuel cell system which has two or more fuel cell stacks.

[0014] In the fuel cell system which has two or more fuel cell stacks, the purpose of further others of this invention is offering the fuel cell system which can continue operating other fuel cell stacks, even when some fuel cell stacks break down.

[0015] Moreover, in the fuel cell system which has two or more fuel cell stacks, another purpose of this invention is offering the fuel cell system which can maintain the utilization factor of fuel gas, even when the amount of generations of electrical energy falls by reduction in a load.

[0016]

[Means for Solving the Problem] Below, The means for solving a technical problem is explained using the number and sign used by [Embodiment of the Invention]. These numbers and signs are added in order to clarify correspondence relation of a publication and [Embodiment of the Invention] of a [claim]. However, don't use those numbers and signs for the interpretation of the technical range of invention indicated by the [claim].

[0017] Therefore, in order to solve the above-mentioned technical problem, the fuel cell system of this invention possesses two or more fuel cell stacks (3-1 - n), two or more power converters (4-1 - n), and a control unit (7). Fuel gas and oxidation gas are supplied to two or more fuel cell stacks (3-1 - n), and they generate the fuel cell power as power. It connects with each of two or more fuel cell stacks (3-1 - n), and two or more power converters (4-1 - n) change the property of the fuel cell power. A control unit (7) controls each of two or more power converters (4-1 - n) mutually-independent. And each of the group of each of two or more fuel cell stacks (3-1 - n) and each of two or more power converters (3-1 - n) is mutually connected to juxtaposition. Moreover, a control unit (7) is controlled to make equal each output voltage of two or more power converters (4-1 - n).
[0018] Moreover, the fuel cell system of this invention controls each output current of two or more fuel cell stacks (3-1 - n) by each of two or more power converters (4-1 - n) so that a control unit (7) makes equal each fuel utilization rate of two or more fuel cell stacks (3-1 - n).
[0019] Moreover, the fuel cell system of this invention possesses further two or more flow rate control units (5-1 - n) which adjust the flow rate of the fuel gas supplied to each of two or more fuel cell stacks (3-1 - n). And a control unit (7) controls each of two or more flow rate control units (5-1 - n) to make equal the flow rate of the fuel gas supplied to each of two or more fuel cell stacks (3-1 - n).
[0020] Furthermore, the fuel cell system of this invention possesses further two or more flow rate control units (5-1 - n) which adjust the flow rate of the fuel gas supplied to each of two or more fuel cell stacks (3-1 - n). And a control unit (7) controls each of two or more flow rate control units (5-1 - n) mutually-independent.
[0021] Furthermore, in a control unit (7), the fuel cell system of this invention controls the number of operation (k) of two or more fuel cell stacks (3-1 - n) so that each the power of the fuel cell of two or more fuel cell stacks (3-1 - n) does not become below the minimum electric energy set up beforehand.
[0022] Furthermore, the fuel cell system of this invention possesses two or more fuel cell stacks (3-1 - n), two or more flow rate control units (5-1 - n), two or more power converters (4-1 - n), and a control unit (7). Fuel gas and oxidation gas are supplied to two or more fuel cell stacks (3-1 - n), and they generate the fuel cell power as power. Two or more flow rate control units (5-1 - n) adjust the flow rate of the fuel gas supplied to each of two or more fuel cell stacks (3-1 - n). It connects with each of two or more fuel cell stacks (3-1 - n), and two or more power converters (4-1 - n) change the property of the fuel cell power. A control unit (7) controls each of two or more groups which have 1 of two or more fuel cell stacks (3-1 - n), 1 of two or more power converters (4-1 - n), and 1 of two or more flow control valves (5-1 - n) mutually-independent. And each of two or more of the groups is mutually connected to juxtaposition.
[0023] Furthermore, the fuel cell system of this invention suspends actuation of the group containing what the failure of two or more fuel cell stacks (3-1 - n) of a control unit (7) generated.
[0024] The operating method of the fuel cell system of this invention for solving the above-mentioned technical problem In the step which supplies the fuel gas of an equal flow rate to each of two or more fuel cell stacks (3-1 - n) mutually connected to juxtaposition, and each of two or more fuel cell stacks (3-1 - n) The step which generates electricity by the fuel utilization rate set up beforehand, and obtains two or more fuel cell power as power, The step which changes each of two or more of the fuel cell power into two or more supply voltages as power which has the electrical potential difference which can be supplied to a load (10), and the step which combines each of two or more of the supply voltages, and is supplied to a load (10) are provided.
[0025] Moreover, the operating method of the fuel cell system of this invention possesses further the step which controls the number of operation (k) of two or more fuel cell stacks (3-1 - n) so that each the power of the fuel cell of two or more fuel cell stacks (3-1 - n) may not become below the minimum electric energy set up beforehand.
[0026] Furthermore, the operating method of the fuel cell system of this invention possesses further the step which is failure of two or more fuel cell stacks (3-1 - n) and which suspends operation, although it generated.
[0027]
[Embodiment of the Invention] Hereafter, the gestalt of operation of the fuel cell system which is this invention is explained with reference to an accompanying drawing. First, the configuration in the gestalt of operation of the fuel cell system which is this invention is explained. Drawing 1 is drawing showing the configuration in the gestalt of operation of the fuel cell system which is this invention. A fuel cell system possesses the fuel gas feeder 1, oxidation gas transfer unit 2, fuel cell stack 3-1 - n (n is the same natural number and the following), DC to DC converter 4-1 - n, and fuel gas flow-control-valve 5-1 - n, and oxidation quantity-of-gas-flow control valve 6-1 - n, a control unit 7, auxiliary machinery 8, and a rechargeable battery 9. And it connects with load equipment 10 and power is supplied to load equipment 10.
[0028] The fuel gas feeder 1 controls supply of the fuel gas supplied to fuel cell stack 3-i through fuel gas flow-control-valve 5-i (i= 1 - n are the same the natural number and the following). Here, fuel gas is gas containing the hydrogen illustrated by the hydeogen-rich gas which reforms hydrocarbon system ingredients, such as

hydrogen or a methanol, and a gasoline, and is obtained. The oxidation gas transfer unit 2 controls supply of the oxidation gas supplied to fuel cell stack 3-i through oxidation quantity-of-gas-flow control valve 6-i. Here, oxidation gas is gas containing oxygen or the oxygen illustrated by air.

[0029] Fuel cell stack 3-i is the aggregate (stack which connected two or more cels to the serial) of the cel which generates electricity using the hydrogen in fuel gas, and the oxygen in oxidation gas. DC to DC converter 4-i (after-mentioned) of dedication has connected with each fuel cell stack 3-i. In drawing 1 , the example in which the group of n fuel cell stacks 3-1 - n, and DC to DC converter 4-1 - n is carrying out parallel connection is shown. Here, fuel cell stack 3-i may connect not only the case of an independent stack but two or more stacks to the case (output voltage can be made high) where it connects with a serial, and juxtaposition (the output current can be made [many]). Moreover, it is illustrated by fuel cells, such as a solid-state macromolecule mold, a phosphoric-acid mold, a melting carbonate mold, and a solid acid ghost mold, as a cel.

[0030] DC to DC converter 4-i is connected to fuel cell stack 3-i at the serial. One DC to DC converter 4-i supports under exclusive contract at one fuel cell stack 3-i (connection). DC to DC converter 4-i changes the fuel cell power as direct current power generated by fuel cell stack 3-i into the direct current power which has a desired property (a desired current and a desired electrical potential difference). Moreover, it is controllable in the current and electrical potential difference of fuel cell power. For example, the current of fuel cell power is controlled to a desired current value by controlling the current pulled out from fuel cell stack 3-i.

[0031] Each of two or more groups of fuel cell stack 3-i, DC to DC converter 4-i, and (fuel gas flow-control-valve 5-i and oxidation quantity-of-gas-flow control valve 6-i) is controlled by the control unit 7 also in the condition that other groups are operated to be able to operate and stop according to an individual, respectively. Moreover, also in the condition that other groups are operated, it is arranged so that it can maintain according to an individual, respectively (repair, exchange, etc.). For example, it is performing incubation currently arranged at suitable spacing according to an individual etc. so that ejection may be possible according to an individual.

[0032] A control unit 7 controls the whole (the fuel gas feeder 1, oxidization gas transfer unit 2, fuel cell stack 3-1 - n, DC to DC converter 4-1 - n, and fuel gas flow-control-valve 5-1 - n, and oxidization quantity-of-gas-flow control valve 6-1 - n, auxiliary machinery 8, and a rechargeable battery 9 are included) fuel cell system. And the thing (for example, it has time sharing and two or more CPUs) for which each of two or more groups of fuel cell stack 3-i, DC to DC converter 4-i, fuel gas flow-control-valve 5-i, and oxidation quantity-of-gas-flow control valve 6-i is controlled independently, respectively is possible.

[0033] Auxiliary machinery 8 is the flow control valve (not shown) of the fuel pump which supplies a fuel to the fuel gas feeder 1, the air compressor which pressurizes and supplies oxidation gas (air) to the oxidation gas transfer unit 2, the cooling water pump which supplies cooling water to the fuel cell stack 3-1 - n, and each pump etc. Although not illustrated, auxiliary machinery 8 is arranged in the fuel gas feeder 1, the oxidation gas transfer unit 2, and the appropriate location of the fuel cell stack 3-1 - n.

[0034] A rechargeable battery 9 is used for supply of the power to load equipment 10 when the fuel cell power by supply of the power for starting of the fuel cell stack 3-1 - n, the storage for a surplus (dump power) of the fuel cell power generated by the load effect, and the load effect is insufficient etc.

[0035] In addition, a capacitor can also be substituted for it every time the function of a rechargeable battery 9 responds to need quantity of electricity. Moreover, external powers (source power supply etc.) can be used for the power for starting. As long as a load effect is within the limits of the load responsibility of fuel cell power, there may not be a rechargeable battery 9.

[0036] In the case of a vehicle use fuel cell system, load equipment 10 is an inverter for a car drive, a motor, etc. In the case of the fuel cell system of a deferment mold, it is a commercial inverter etc.

[0037] Next, the actuation in the gestalt of operation of the fuel cell system which is this invention is explained with reference to drawing 1 . By control of a control unit 7, at the time of starting, auxiliary machinery 8 receives an electric power supply from a rechargeable battery 9, and starts the fuel cell stack 3-1 - n. And it changes into the condition (conditions, such as temperature, a pressure, fuel gas, and oxidation gas) which can generate the fuel cell stack 3-1 - n.

[0038] When a generation of electrical energy of the fuel cell stack 3-1 - n is attained, a control unit 7 connects load equipment 10 to the fuel cell stack 3-1 - n electrically, and makes fuel cell power output. A control unit 7 determines the magnitude of the fuel cell power which the fuel cell stack 3-1 - n are made to generate based on the magnitude of the load of load equipment 10, the amount of accumulation of electricity of a rechargeable battery 9, and the amount of the power used of auxiliary machinery 8 in that case. For example, when the load of load equipment 10 is small, the power of auxiliary machinery 8 and load equipment 10 is provided only with the output of the fuel cell stack 3-1 - n. Then, when there are few amounts of accumulation of electricity of a rechargeable battery 9, dump power is generated and a rechargeable battery 9 is charged. When the load of load equipment 10 is large, the power of auxiliary machinery 8 and load equipment 10 is provided with the output of

the fuel cell stack 3-1 - n, and a rechargeable battery 9. Measurement of each power is measurable with an ammeter, a voltmeter, a wattmeter, etc. which have been arranged at each configuration. Moreover, the logic of the amount decision of generations of electrical energy can use the approach used conventionally.

[0039] It determines whether all of the fuel cell stacks 3-1 - n are made to generate a control unit 7 after the decision of the magnitude (total amount) of the fuel cell power which the fuel cell stack 3-1 - n are made to generate. This is judged by whether the amount of generations of electrical energy of each fuel cell stack 3-i turns into below the amount of the minimum generations of electrical energy set up beforehand. namely, the fuel cell stack 3 (-1 - n) -- the amount of the amount of generations of electrical energy (magnitude (total amount)/n of = fuel cell power) > minimum generations of electrical energy per set -- if it becomes, it will control to make all of the fuel cell stacks 3-1 - n generate electricity. If it becomes, it will ask for the magnitude (total amount)/the amount of the n<= minimum generations of electrical energy of fuel cell power, and k (k (<=n) is the natural number) used as the magnitude (total amount)/the amount of the k> minimum generations of electrical energy of fuel cell power. And it controls to make only k in the fuel cell stack 3-1 - n generate electricity.

[0040] It is possible to carry out by the approach of arbitration, although k sets are chosen from n sets. for example, or it chooses at random so that a bias may not arise in selection, each fuel cell stack 3-i is comparable within the period which memorizes the accumulation generating duration (the amount of generations of electrical energy) of each fuel cell stack 3-i within the control unit 7, and was set up beforehand -- it distributes so that time amount (amount of generations of electrical energy) use may be carried out.

[0041] Making it control as mentioned above is based on the following reasons. In operation of a fuel cell, keeping constant the utilization factor (fuel utilization rate = amount of the fuel gas supplied to the amount/fuel cell of the fuel gas used for the generation of electrical energy) of fuel gas, and operating from the field of effectiveness, is called for. On the other hand, fuel gas is also bearing the role which drains a part for the redundant water in the fuel cell which degrades generating efficiency (intact water and generation water). Therefore, when fuel gas is decreased in order to make the utilization factor of fuel gas regularity in case the amount of generations of electrical energy is decreased, the fall of the wastewater capacity will be caused. Consequently, decline in generating efficiency will be caused. Therefore, it is desirable not to perform the generation of electrical energy below a certain amount of generations of electrical energy (the amount of the minimum generations of electrical energy) (in carrying out, rather than the flow rate of the fuel gas which can be found from the utilization factor of fuel gas, there is the need of passing much fuel gas and effectiveness falls).

[0042] Next, a control unit 7 controls the fuel gas flow control valve 5-1 corresponding to the selected fuel cell stack 3 (referred to as the fuel cell stack 3-1 - k in this example) - k, and the oxidation quantity-of-gas-flow control valve 6-1 - k, and supplies an equal quantity of fuel gas and oxidation material gas to each of the selected fuel cell stack 3-1 - k. It is determined that the amount of supply of fuel gas will become the fuel utilization rate set up beforehand based on the magnitude of output current Iin-1 made to output to each of the selected fuel cell stack 3-1 - k - k. Moreover, it is determined that the amount of supply of oxidation gas will become the ratio of oxygen utilization set up beforehand based on the magnitude (or fuel utilization rate of fuel gas) of output current Iin-1 - k. The value of a fuel utilization rate and a ratio of oxygen utilization is stored in the control unit 7.

[0043] A control device 7 controls each DC to DC converter 4-1 - k, and output current Iin-1 of the selected fuel cell stack 3-1 - k - k are made to become an equal value. That is, an equal quantity of fuel gas will be supplied to all each of the selected fuel cell stack 3-1 - k, and it will generate all by equal output current Iin-1 - k (= fuel gas consumption is equal). Therefore, all the fuel utilization rates of the selected fuel cell stack 3-1 - k serve as an equal value.

[0044] Although all each of the selected fuel cell stack 3-1 - k generates electricity by equal output current Iin-1 - k (= fuel gas consumption is equal), the relation (it illustrates to drawing 3) of each output current and output voltage differs. Therefore, output voltage Vin-1 - k become a value which is different in every fuel cell stack 3-1 - k.

[0045] Each DC to DC converter 4-1 - k are changed into power Pout-1 which has the system electrical potential difference VS which becomes settled based on auxiliary machinery 8, a rechargeable battery 9, and load equipment 10 about fuel cell power Pin-1 - k (output voltage Vin-1 - k, and output current Iin-1 - k) - k (= rhoxVin -1 kxIin -1 - k). However, rho is the power conversion effectiveness of DC to DC converter 4-1 - k. current Iout-1 at that time - k -- Iout-1 k=rhoxVin -1 kxIin -1 - k/VS -- it comes out.

[0046] Power Pout-1 changed - k (Iout- 1- k, VS) are consumed with auxiliary machinery 8 and load equipment 10. A rechargeable battery 9 stores electricity dump power.

[0047] Even if it supplies an equal quantity of fuel gas to each of the fuel cell stack 3-1 from which an output

current-output voltage property differs - n by the above actuation, since the output current is fixed, the excess and deficiency of fuel gas are not produced. Therefore, in all of the fuel cell stacks 3-1 - n, it becomes [operating fuel utilization rate regularity or] possible. And since an equal quantity of fuel gas will be altogether supplied to each of the fuel cell stack 3-1 - n in this case, control of fuel gas becomes it can be very easy and controllable [stable].

[0048] Moreover, output voltage Vin-1 - n can presuppose that it is fixed on the output voltage = system electrical potential difference VS in each of DC to DC converter 4-1 - n also with a value which is different in every fuel cell stack 3-1 - n. That is, it becomes possible by using DC to DC converter 4-1 - n to carry out parallel connection of each fuel cell stack 3-1 - the n with the equal output voltage VS.

[0049] The fuel cell stack 3-1 - n are parallel connection, and since adjustment of the amount of generations of electrical energy is controlled by the control device 7 using DC to DC converter 4-1 - n, each of the fuel cell stack 3-1 - n becomes possible [controlling independently to the remaining fuel cell stacks 3-1 - n]. That is, even when some of the fuel cell stack 3-1 - the n need to be stopped for the reasons of failure etc., it becomes possible to continue the remaining operation.

[0050] Moreover, since each of the fuel cell stack 3-1 - n can be independently controlled even when the amount of generations of electrical energy decreases (operation and a halt are included), it is possible to correspond by reducing the number of the fuel cell stack 3-1 to generate - n. Thereby, the amount of generations of electrical energy per fuel cell Stack 3-1 - n Kazumoto can be made [more] than the minimum electric energy, and decline in the system efficiency by aggravation of a fuel utilization rate can be prevented.

[0051] Moreover, since each of the fuel cell stack 3-1 - n is independently controllable, it is also possible to control the flow rate of the fuel gas to supply according to the condition of each fuel cell stack 3-i (based on fuel gas flow-control-valve 5-i), and to control independently the fuel utilization rate in each fuel cell stack 3-i. It becomes possible to continue operation until fuel cell stack 3-i in which the engine performance deteriorated can also extend duration of service, for example, can prepare the spare fuel cell stack 3 by that cause.

[0052]

[Effect of the Invention] It enables it for the fuel gas consumption in each fuel cell stack not to depend on a fuel cell stack, but to suppose that it is fixed by this invention, when connecting a fuel cell stack to juxtaposition.

[Translation done.]